

2nd Group of Experts Meeting on
Whiplash Injury Criteria

**On Candidate Seat Performance / Injury
Criteria for Regulatory Purposes**

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EUROPEAN ENHANCED VEHICLE-SAFETY COMMITTEE



Bundesministerium
für Verkehr, Bau
und Stadtentwicklung



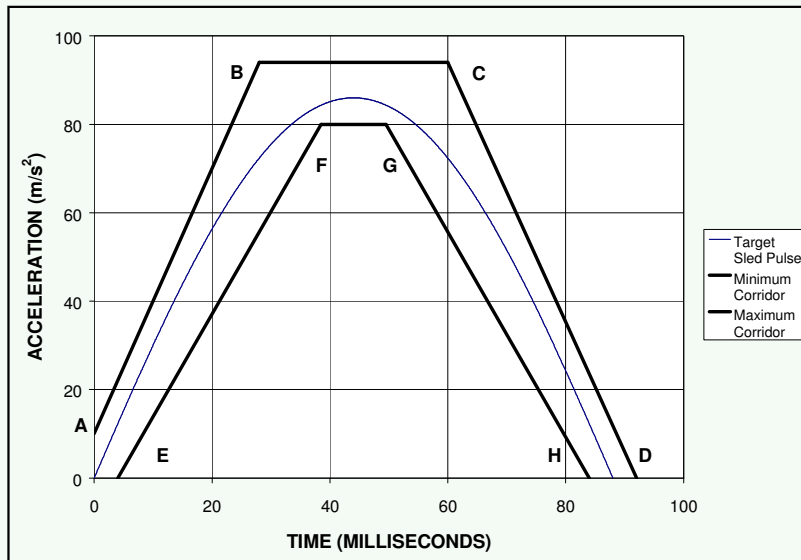
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Ministry of Land, Infrastructure and Transport

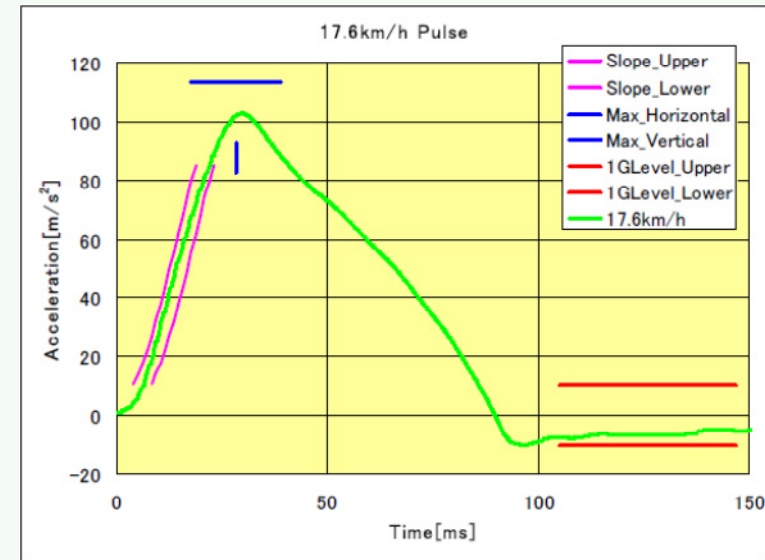


Test Pulse



$D v = 17.3 \text{ kph} \pm 0.6$

**Current GTR No. 7 Annex 9
(Hybrid III)**



**Draft new GTR No. 7 Phase 2
(BioRID II)**

Candidate seat performance criteria (as of doc GTR7-06-10 and proposed by Japan):



- Neck Injury Criterion (NIC): NICmax shall not exceed [23.4].
- Upper Neck Fx, flexion and extension: Fxmax shall not exceed [61.3].
- Lower Neck Fx, flexion and extension: Fxmax shall not exceed [61.3].
- Upper Neck Fz: Fzmax shall not exceed [933.5].
- Lower Neck Fz: Fzmax shall not exceed [1113.1].
- Upper Neck My: My^{oc}max shall not exceed [31.6].
- Lower Neck My: Mymax shall not exceed [31.6].



Candidate seat performance criteria

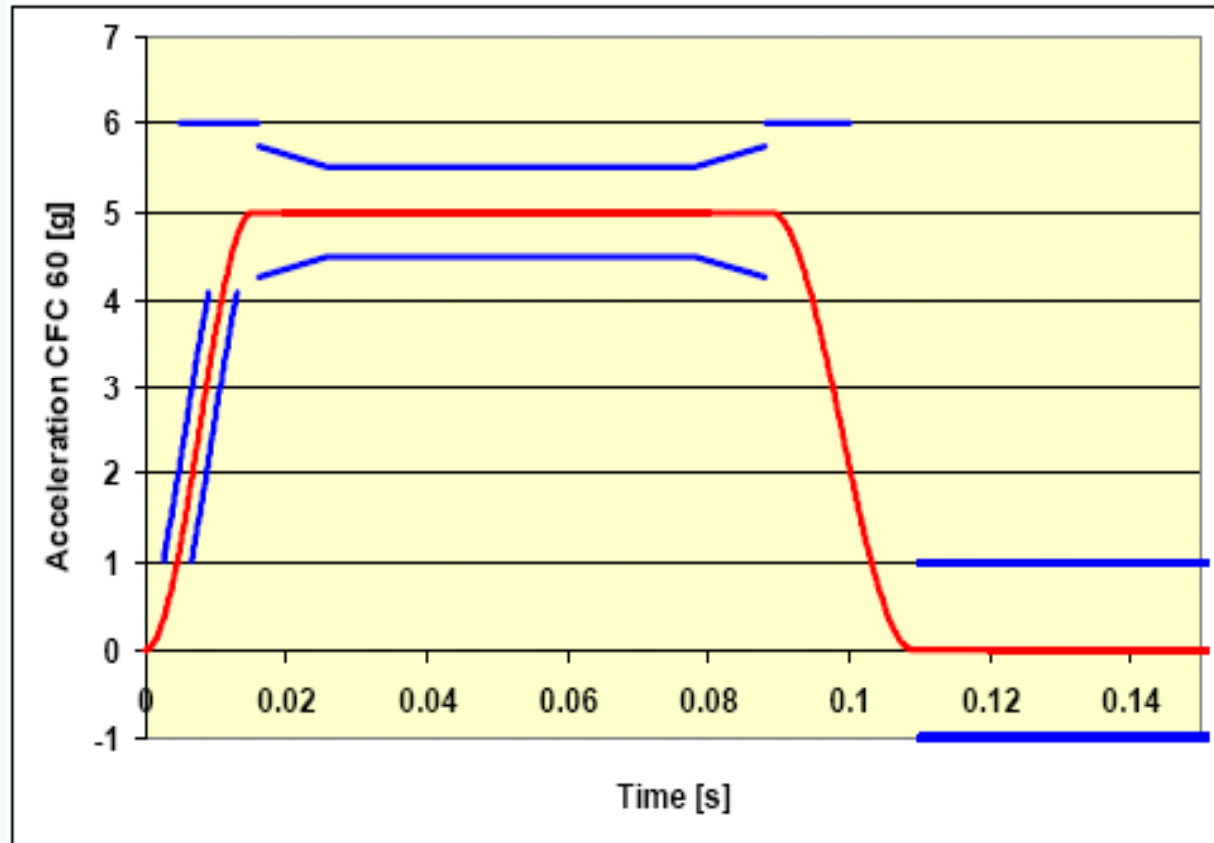
After 1st Group of Expert Meeting September 2014:

- Neck Injury Criterion (NIC)
- Fx upper and lower neck (flexion and extension?)
- NDCrot for both flexion and extension

My upper and lower neck was deleted provided that NDCrot has requirements for both flexion and extension.

Test pulses 16 km/h low severity pulse (pulse 1)

subject	Requirement	Limits +/-	Unit	
Velocity change	dV	16.10	0.80	km/h
Time span	dT	105.8	3.0	ms
Mean acceleration	Amean	42.35	4.5	m/s ²
Acceleration at T0	AT0	0	2.5	m/s ²

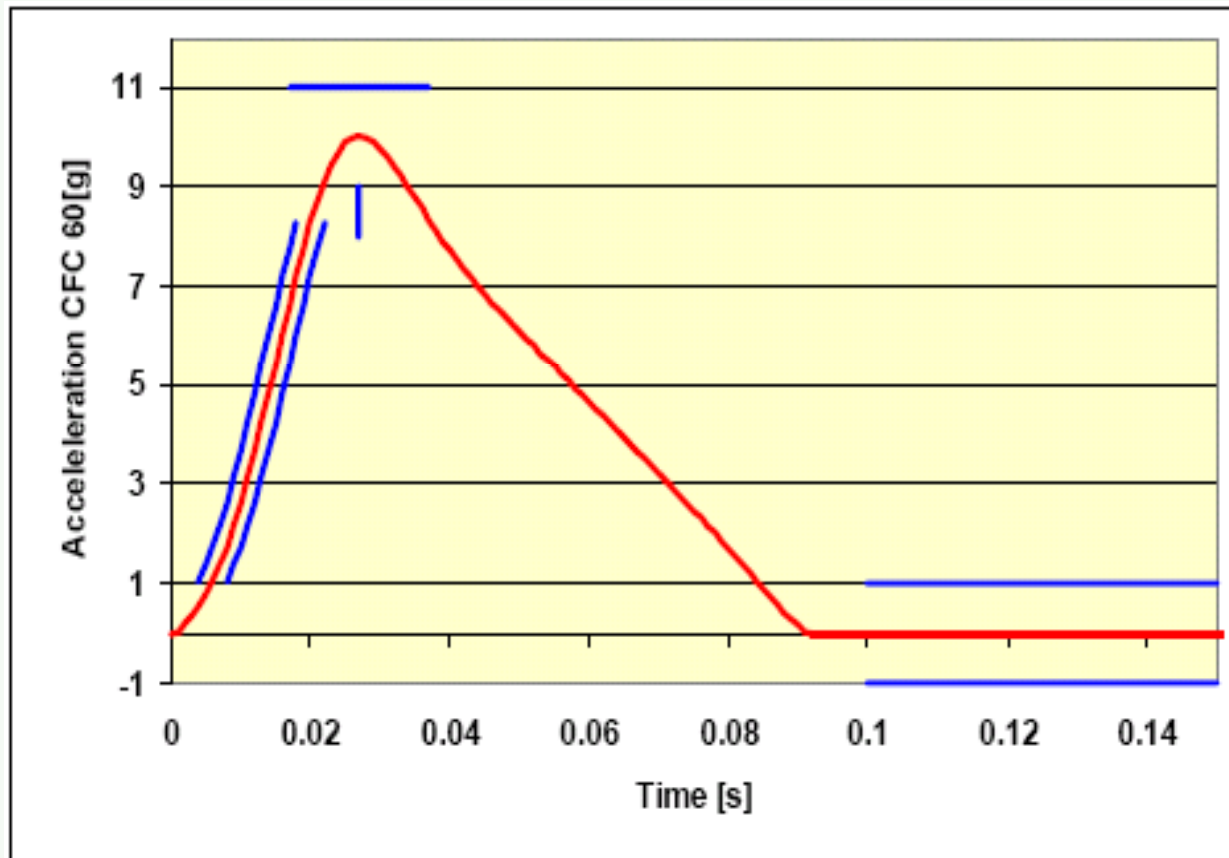


Pulse 1 "Low Severity", red: target curve, blue: corridor

Test pulses

16 km/h medium severity (IIWPG) pulse
(pulse 2)

subject		Requirement	Limits +/-	Unit
Velocity change	dV	15.65	0.80	km/h
Time span	dT	91.00	3.00	ms
Mean acceleration	Amean	47.85	4.00	m/s ²
Acceleration at T0	AT0	0	2.5	m/s ²

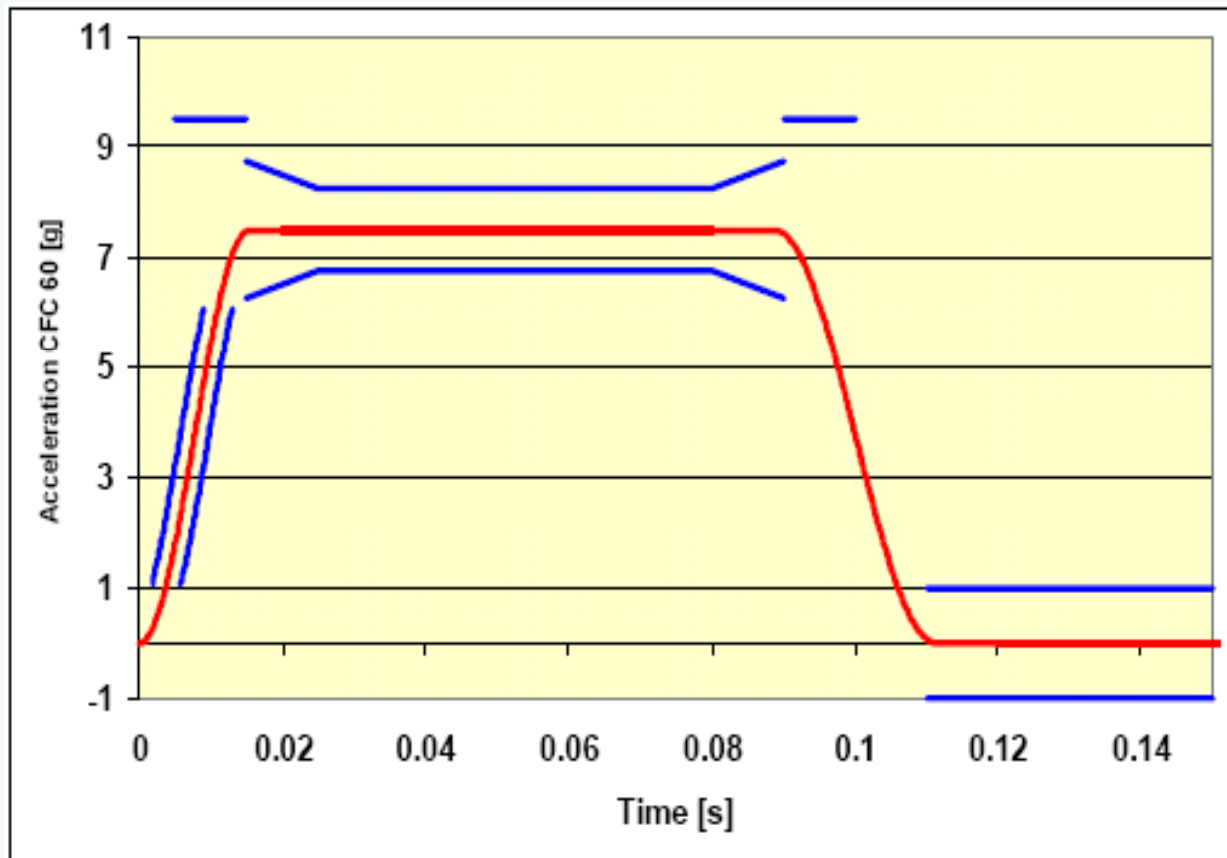


Pulse 2 "Medium Severity", red: target curve, blue: corridor

Test pulses

24 km/h high severity pulse (pulse 3)

subject	Requirement	Limits +/-	Unit	
Velocity change	dV	24.45	1.2	km/h
Time span	dT	107.7	3.00	ms
Mean acceleration	Amean	63.15	4.85	m/s ²
Acceleration at T0	AT0	0	2.5	m/s ²



Pulse 3 "High Severity", red: target curve, blue: corridor

Seat performance criteria

Seven criteria are assessed during the dynamic test related to dummy response

NIC	Relative horizontal acceleration and velocity of the occipital joint relative to T1
Nkm	Combination of moment and shear forces
HRV	Head rebound velocity
F_{x upper}	Upper neck shear force
F_{z upper}	Upper neck tension force
T1g	Acceleration on 1st thoracic vertebra (T1)
HRC	Time to head restraint first contact

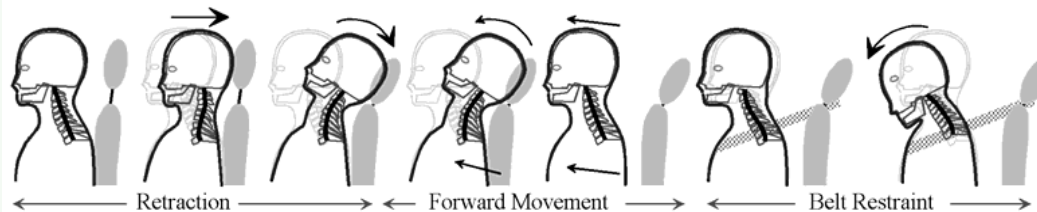


Figure from Trauma-Biomechanik by Schmitt, Muser

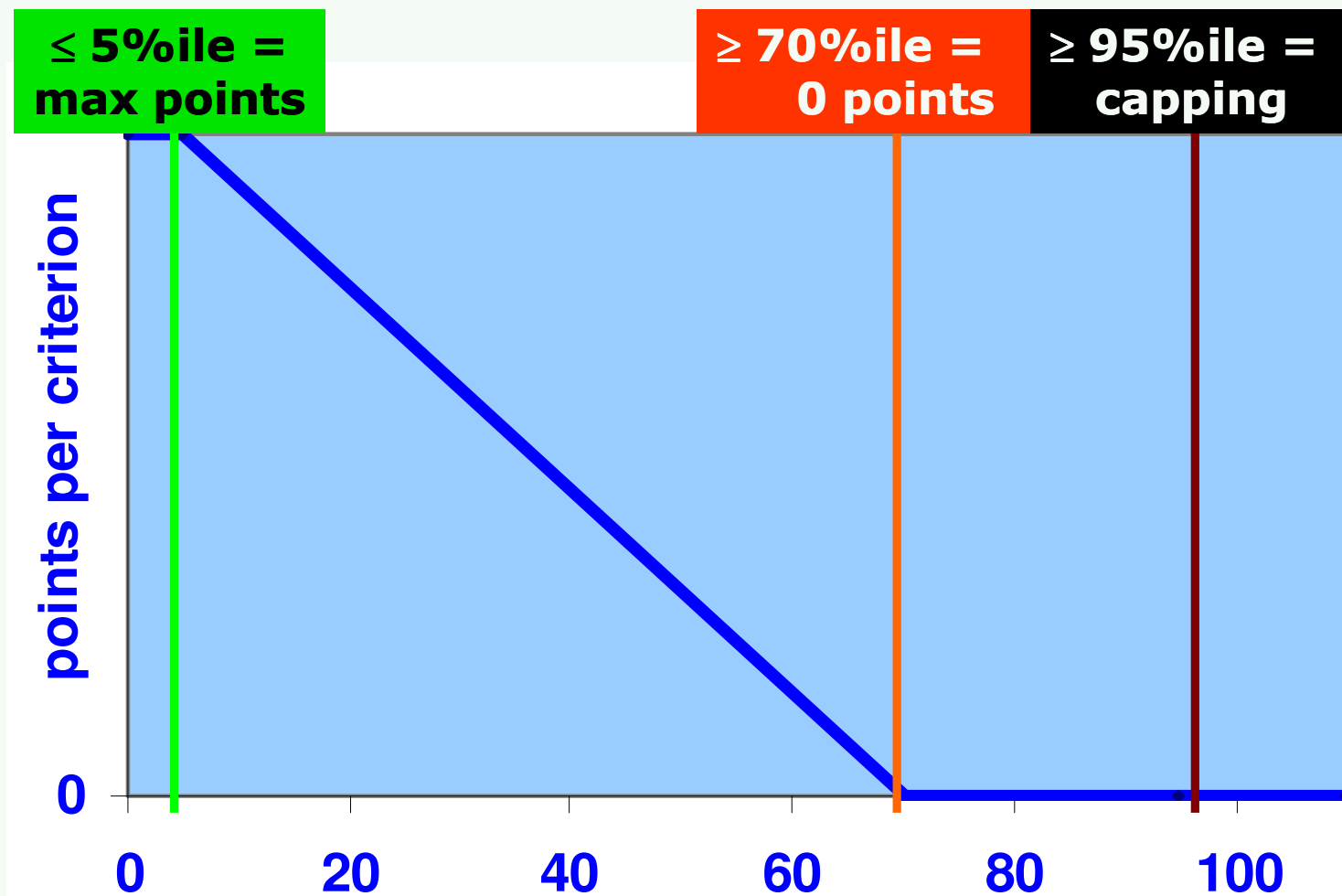
Rating System

Sliding scales and capping limits

- For the dynamic test, sliding scales are used for all criteria.
- For each test severity different limits for the criteria have been generated following the “best practise” approach.
- The sliding scales appropriate to each pulse have been generated from an [Assessment Protocol Prove Out \(APPO\)](#) test programme in 2006 with 30 seat models (90 tests).
- Sliding scale limits are based on the 5th and 70th percentile figures of the APPO data.
- Capping applied if one of the criteria is above the 95th percentile (-> 0 points for test)

Rating system

Sliding scale for point scoring of seat performance criteria



Criterion value in %-ile of best practise range on base of APPO results

Euro NCAP Lower-, upper-, and capping limits

Euro NCAP Criteria	Units	Low Severity			Medium Severity			High Severity		
		HPL	LPL	CL	HPL	LPL	CL	HPL	LPL	CL
NIC	m ² /s ²	9,00	15,00	18,30	11,00	24,00	27,00	13,00	23,00	25,50
Nkm	-	0,12	0,35	0,50	0,15	0,55	0,69	0,22	0,47	0,78
Rebound velocity	m/s	3,00	4,40	4,70	3,20	4,80	5,20	4,10	5,50	6,00
Upper Neck Shear Fx	N	30,00	110,00	187,00	30,00	190,00	290,00	30,00	210,00	364,00
Upper Neck Tension Fz	N	270,00	610,00	734,00	360,00	750,00	900,00	470,00	770,00	1024,00
T1 acceleration	g	9,40	12,00	14,10	9,30	13,10	15,55	12,50	15,90	17,80
Time to head restraint first contact	ms	61,00	83,00	95,00	57,00	82,00	92,00	53,00	80,00	92,00
Seatback Deflection	deg	n/a			n/a			32		

HPL: Higher Performance Limit

LPL: Lower Performance Limit

CL: Capping Limit

Euro NCAP Lower-, upper-, and capping limits for criteria under discussion

Euro NCAP Criteria	Units	Medium Severity			High Severity		
		HPL	LPL	CL	HPL	LPL	CL
NIC	m ² /s ²	11,00	24,00	27,00	13,00	23,00	25,50
Upper Neck Shear Fx	N	30,00	190,00	290,00	30,00	210,00	364,00

My is measured but not part of the assessment

HPL: Higher Performance Limit

LPL: Lower Performance Limit

CL: Capping Limit

Experience from Euro NCAP seat performance assessment since 2008

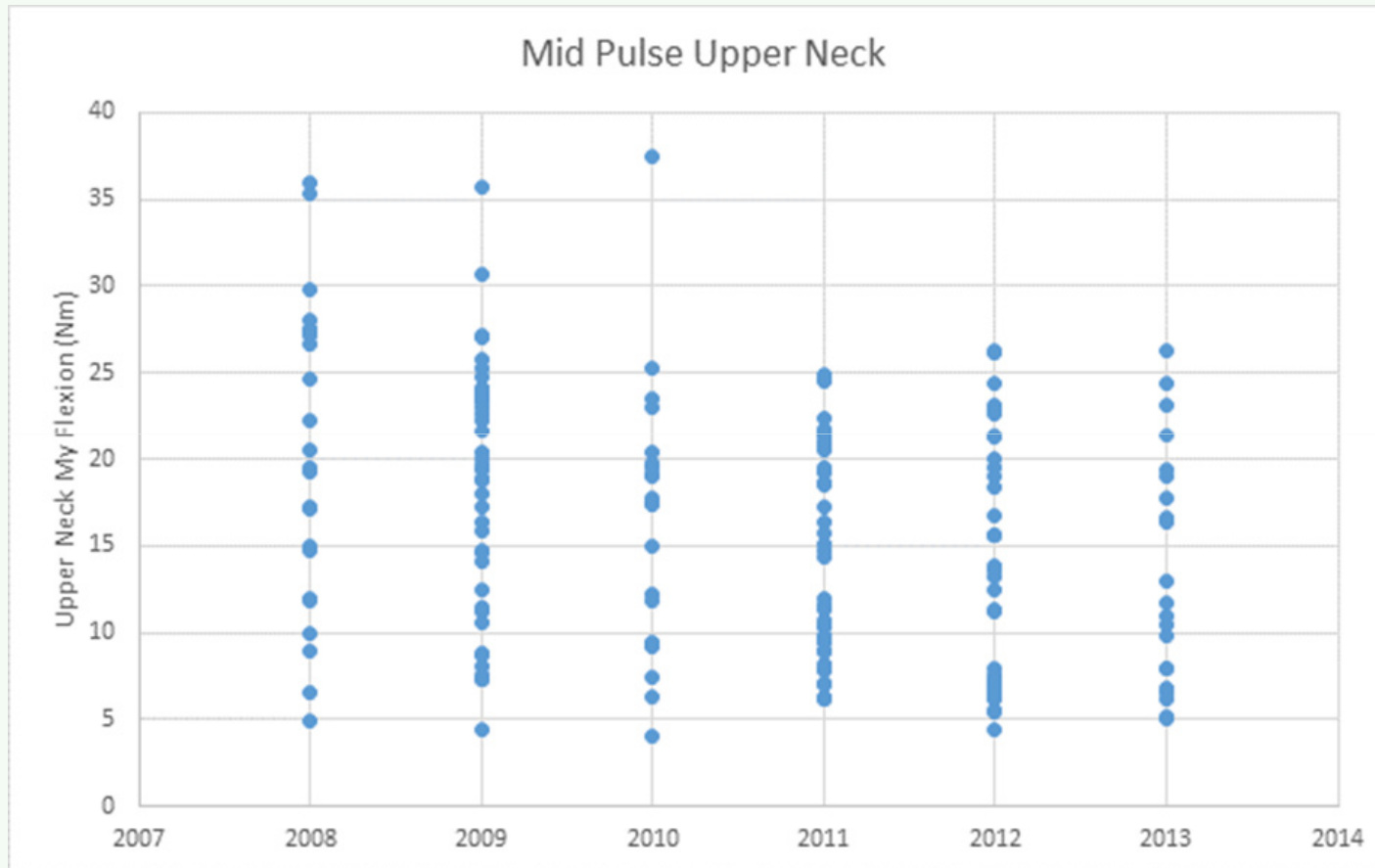
- Out of **88 seat models** tested between **2008 and 2010**:
 - High pulse was capped for 8 models.
 - Mid pulse was capped for 4 models.
 - Low pulse was capped for 4 models.
- Out of **152 models tested** between **2011 and 2014 only 4** vehicles had a whiplash pulse score capped
 - 2011 **one** car, low pulse, **rebound velocity**
 - 2011 **one** car, high pulse, **rebound velocity**
 - 2012 **one** car, high pulse, most criteria (very bad seat)
 - 2013 **one** car, high pulse, **rebound velocity**.
 - 2014 **no capping!**

No capping applied for candidate injury criteria NIC, Upper Neck Fx

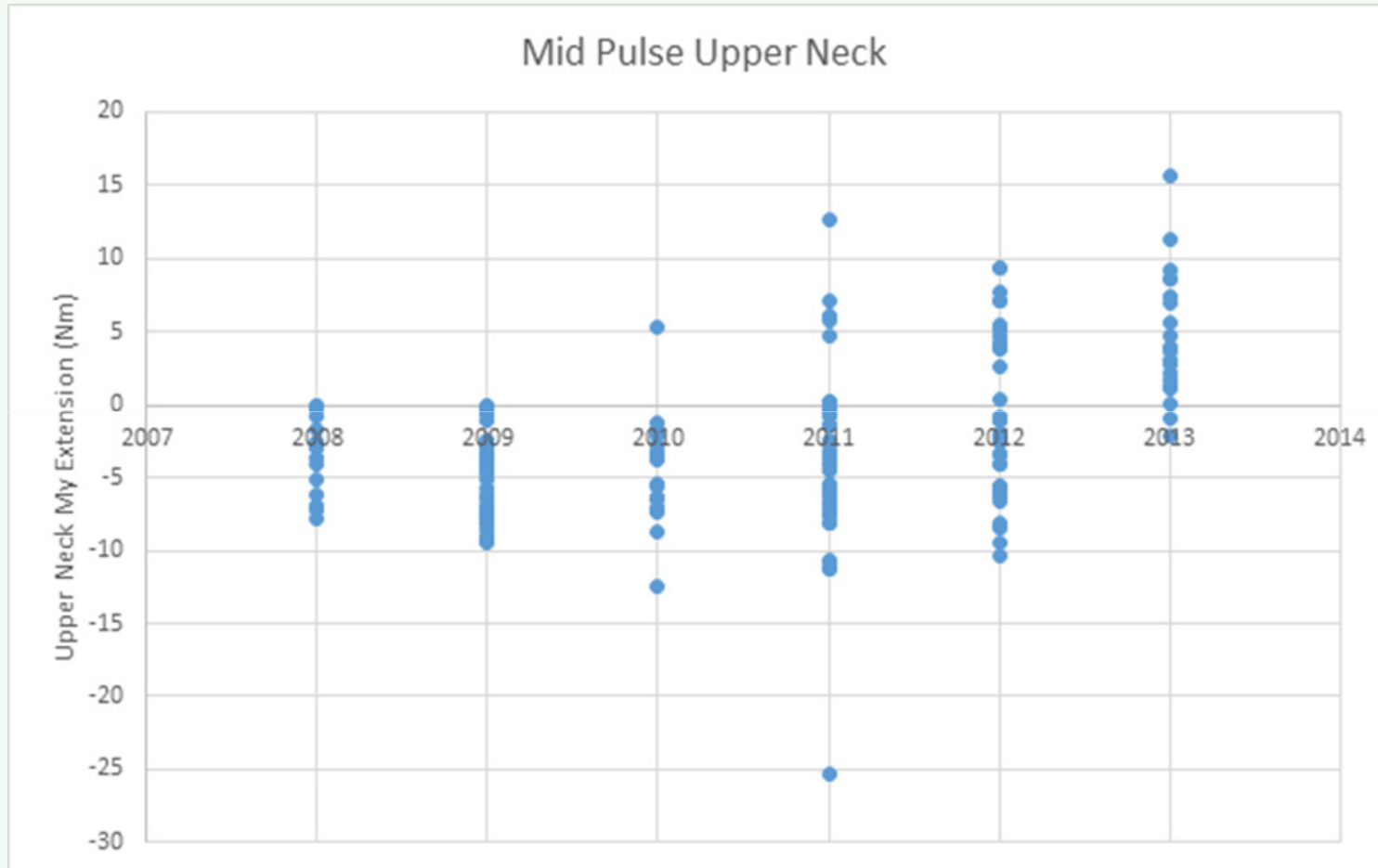
Experience from Euro NCAP seat performance assessment since 2008

- Tests are currently performed in 7 European labs which received „Euro NCAP accreditation“:
 - ADAC, BAST, CSI, IDIADA, Thatcham, TNO, UTAC
- Different BioRIDs are used
- Dummies are certified according to the „old“ procedure

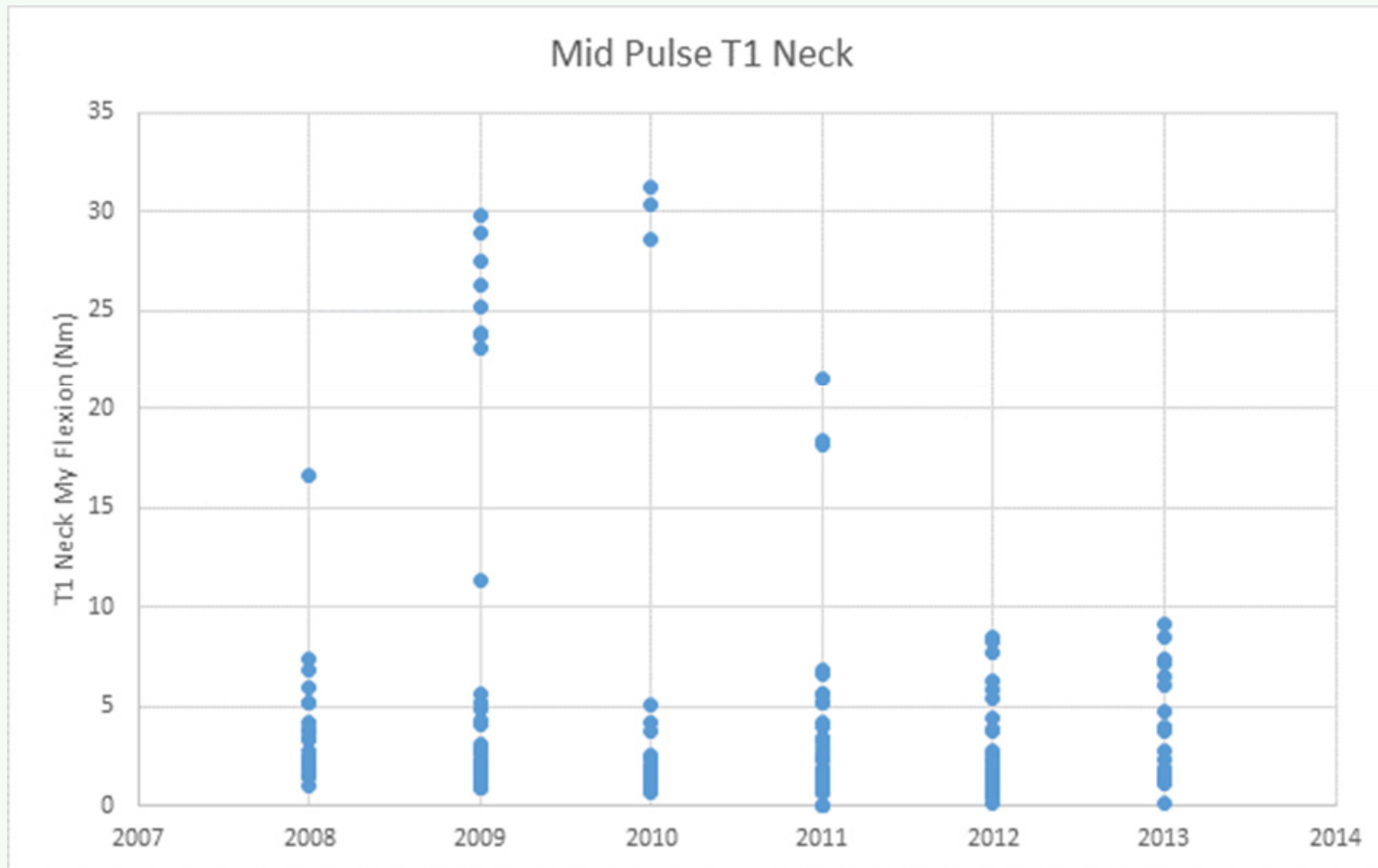
Upper Neck My Flexion (Euro NCAP Data 2008-2013)



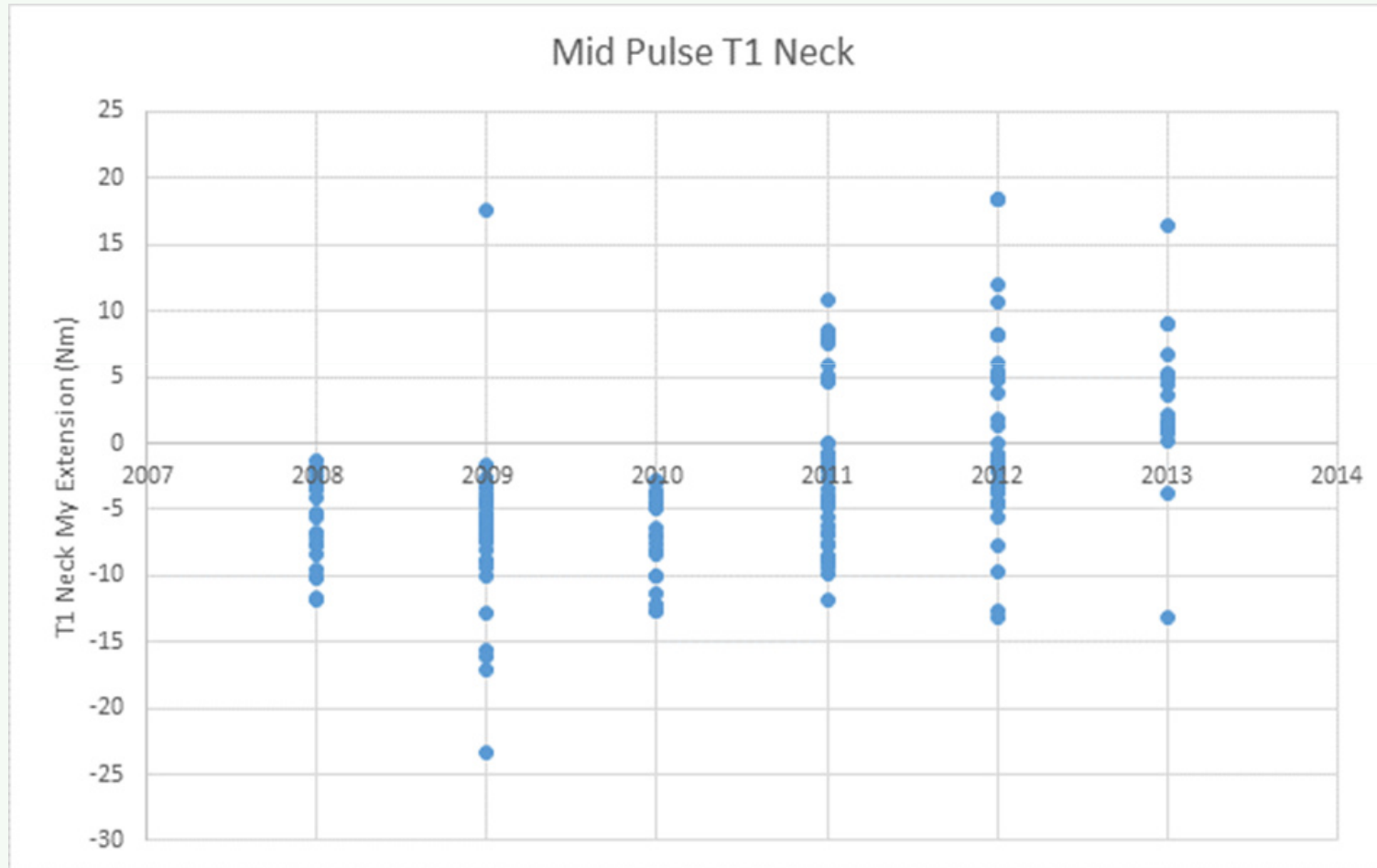
Upper Neck My Extension (Euro NCAP Data 2008-2013)



Lower Neck My Flexion (Euro NCAP Data 2008-2013)



Lower Neck My Extension (Euro NCAP Data 2008-2013)



Japan Proposal Injury Evaluation Parameters and Injury Criteria for GTR7

Injury Criteria		AIS1+: 50% Value <Equivalence> WAD2+: 82.9% Value
		IV-NIC=1.1
NIC Max		23
Upper Neck	FX (Backward)	640
	MY(Flx/Ext)	34
Lower Neck	FX (Backward)	640
	MY(Flx/Ext)	34

Units: Force (N)
Moment (Nm)

Discussion

NIC

NICmax 23 (Japan)

NICmax 25 (EEVC for long term injuries)

NICmax 15 (Literature)

No rating capped due to NIC since 2011 at Euro NCAP

Recommendation for GTR 7: NICmax 23 ?

Upper and Lower Neck Fx

Fxmax (backwards) 640 N (Japan)

Fxmax 210 N (EEVC, tentative)

Upper Neck Fx Capping Limit 364 N (Euro NCAP high severity pulse)

No rating capped due to Upper neck Fx since 2011 at Euro NCAP

Recommendation for GTR 7: Upper and Lower Neck Fx 360 N?

Discussion

Upper and Lower Neck My

Mymax (flex/ext) 34 Nm (Japan)

Recommendation for GTR 7: Mymax 30 Nm?

Summary of recommendations for GTR 7

NIC	23 ?
Upper and Lower Neck Fx	360 N ?
Upper and Lower Neck My	30 Nm ?

Thank you for your attention !



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